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An Analysis of Learning Process Based on Scientific Approach in Physical Chemistry Experiment

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Abstract. This study aimed to analysis the quality of learning process based on scientific approach in physical chemistry experiment of Chemistry Education students, Islamic University of Indonesia. The research was descriptive qualitative. The samples of this research were 2nd semester student, class of 2015. Scientific data of learning process were collected by observation sheet and documentation of seven title experimental. The results showed that the achievement of scientific learning process on observing, questioning, experimenting and associating data were 73.98%; 81.79%; 80.74%; and 76.94% respectively, which categorized as medium. Furthermore, for aspect communicating had high category at 86.11% of level achievement.

INTRODUCTION

In education there is one thing that very important that the subject of the development of an education is the quality of education. The quality of education can be improved by good by way of utilizing the natural resources that exist. Abundant natural resources will be more helpful if it is followed by the quality of human resources as well. One way to realize the quality of education in Indonesia to make it better is to conduct educational activities that are innovative, creative and has the right destination.

To get a better quality of education, is not easy because they have to understand the quality of education in Indonesia. Nowadays the quality of education in Indonesia still requires special attention. Based upon the results of the study Trends in International mathematics and Science Study (TIMSS) in 2007, showed that their achievements were not satisfactory. Mathematical literacy learners in Indonesia mperingkat occupy 36 of the 49 countries, where the score obtained is 405 and the score is below the international average score is 500. Not much different with mathematical literacy, scientific literacy for Indonesia is ranked 36th out of 49 countries, with the achievement of a score of less than the international minimum score is 433[1].

According to the OECD (2006), when viewed from the study report Program for International Student Assessment (PISA) in 2003, the quality of education in Indonesia for Science and Mathematics Literacy is ranked in position 39 of the 40 participants. In 2006, mathematical literacy is ranked 50th out of 57 countries, and ranks 50th out of 57 for science literacy [2]. Also based on the results of a survey conducted by the Program for International Student Assessment (PISA) in 2012 reported that in the field of science (science) students Indonesia was ranked 64th out of 65 countries with an average score of 382 is also under Malaysia with an average score of 420, Thailand with an average score of 444, and Singapore with an average score of 551. the first order was also occupied by students from Shanghai China with an average score of 580 [3]. The surve report in addition to showing the quality of education in Indonesia is still low, especially in science learning, also indicate the educational process is not going as it should.

Science is one branch of science that is commonly known as the Natural Sciences in which is divided into three sciences are chemistry, physics and biology. Science should be possessed by students in the implementation of physical chemistry in particular subjects Study Program of Chemistry is chemistry and physics in addition. Students typically receive theoretical knowledge in the classroom given by lecturers. Students get the concepts of material

physics chemistry algorithmically, but when applied to the concept that there should be a learning more emphasis on hands-on activity, namely through the course Practical Physical Chemistry.

Experiments activity in a learning is a tool for students in understanding science. Experiments activity is to do a proofing by applying the theory in real activity. Through the practicum students can conduct scientific activities in the laboratory. Scientific approach able to assist learners in mastering the material and laboratory skills with carry out important five activities in scientific approach. Five of these activities is to observe, ask, try, associate (reasoning), and communicate.

Scientific approach first introduced in the United States of science education in the 19th century, as the emphasis on formalistic laboratory methods that lead to scientific facts [4,5]. The scientific method has the characteristics of "doing science". This method allows teachers or curriculum developers to improve the learning process, namely by breaking the process down into steps or stages in detail which contains instructions for the students carry out learning activities [6]. This is the basis of curriculum development in 2013 in Indonesia.

Scientific approach is an approach in the curriculum of 2013. In practice, there is made a scientific approach, or method. However, the characteristics of the scientific approach is no different from the scientific (scientific method). In accordance with Standard Competency, learning objectives include the development of the realm of attitudes, knowledge, and skills that are elaborated for each educational unit.

Skills acquired through activity "observing, questioning, experimenting, associating and communicating". Characteristics of competence along the path difference acquisition participate affect the characteristics of the standard process:

1. Observing

Method of observing were more prioritize of meaningfulness learning process (meaningfull learning). This method has certain advantages, such as presents the object media as real , this can made the students happy and were challenged, and easy for implementation. Of course, the observing activity in the context of this study usually requires a long preparation time and mature, relatively high cost and effort, and if can not do the best will obscure the meaning and purpose of learning.

2. Questioning

Effective teachers can inspire students to improve and develop the realm of attitudes, skills and knowledge. By the time the teacher asked, at the same time in charge of guiding or guide the students to learn well. When the teacher answered student questions, when it also served to encourage their students to be good listeners and learners.

3. Experimenting

To obtain a real or authentic learning, students should try or do laboratory work, especially for materials or substances that are compatible. In physics, for example, students should understand the concepts of physics and its relationship to daily life. Students must also have the skills to develop knowledge of the environment, as well as being able to use the scientific method and scientific attitude to solve the problems they face everyday.

4. Associating

The term "making sense" within the framework of the learning process with a scientific approach adopted in the curriculum in 2013 to illustrate that the teacher and students are active actors. The emphasis of course in many ways and situations students must be more active than the teacher. Reasoning is the process of thinking logically and systematically over-the word empirical facts that can be observed to obtain a conclusion in the form of knowledge. Reasoning question is the scientific reasoning. The experiences that have been stored in the memory of the brain relate and interact with prior experience are already available. That process is known as association or reasoning.

5. Communicating

Collaborative learning is a personal of philosophy , is more than learning techniques in classes of school . Collaboration is a philosophy and lifestyle of human interaction that locates and interpret cooperation as a structure interaction, well-designed and intended to facilitate collective efforts in order to achieve a common goal [7].

According to the regulations the Minister of National Education 16, 2007, Practical chemistry in the laboratory can not be separated from chemistry to gain experience learning laboratory, science process skills and experience to the investigation. This activity at the college is expected to be implemented by the students so that students are able to become graduates competent for the field [8].

Physical Chemistry experiment is awarded at the beginning of the semester in which the second half Prodi chemical education. Proficiency of students in the laboratory was not refined because students are still trying to learn the new laboratory activities are very different from Senior High School laboratory Physical chemistry

experiment was implemented to provide a clearer about the material of physical chemistry that has been obtained students in theory classes. Many things can be done in a laboratory which aims to prove a theory. This activity is not an easy thing so that the necessary of specialist skills in the laboratory. These skills can be seen through a scientific approach which is the scientific activities conducted in the laboratory such as observing, ask, try / investigate, reason and communicate.

The success of implementing the learning is often seen on the final assessment of learners. Whereas a learning process always influenced by factors that occur during the learning process takes place. If this is used for penilaian successful implementation of the learning process in the laboratory, of course it is a bad impact on learners. According⁷, the successful implementation of learning management and laboratory techniques, not simply determined from the final value obtained by students or have the skills to manage the laboratory work, but will also affect the competence of graduates learners in particular the ability of science. Provision of direct experience is a must on these subjects. For science, laboratory work skills are a must and needs to be able to organize a qualified laboratory work. So with the explanation that has been described above, it is necessary of analysis the success of the learning process by using a scientific approach to determine the successful implementation of the scientific approach was implemented on Chemical Education study program, in order to obtain a graduate as expected.

RESEARCH METHODS

1. Design Research

This research was quantitative. Quantitative research methods attempt to maximize objectivity, replicability, and generalizability of findings, and are typically interested in prediction.[9]

2. Research Subjects

Subjects in this study were students of department of chemistry education Universitas Islam Indonesia, the 2nd semester student, class of 2015, as many 24 people.

3. Research Instruments

The research instrument used in this study is the observation sheet of learning activities in laboratory and documentation. Observation sheet contains five aspects of the scientific approach.

TABLE 1. The linkage scientific approach with the Learning Activities and Meaningfulness [10]

Aspect of Scientific Approach	Learning Activity
Observing	<ol style="list-style-type: none"> 1. Reading 2. Hearing 3. Listening 4. Viewing or Sensing (without or with tool)
Questioning	<ol style="list-style-type: none"> 1. Asking questions about the information that is not understood from what is observed 2. Asking questions to gain additional information about what is observed 3. Asking questions that is from fact 4. Asking questions that is from concept 5. Asking the question that is from hypothetical
Experimenting	<ol style="list-style-type: none"> 1. Conducting experiments 2. Reading of sources other than books 3. Observing objects / events 4. Activities (learner activity) 5. Interviews with resource persons
Associating	<ol style="list-style-type: none"> 1. Finding links between the various information collected 2. Finding patterns of relatedness of the various information collected 3. Summing up of the sharing pattern found 4. The information is processed to add breadth and depth of knowledge 5. Processing of information collected for search of solutions from a variety of sources that have different opinion 6. Processing information collected for search of solutions from a variety of sources that contradict
Communicating	<ol style="list-style-type: none"> 1. Deliver the result of observations orally, in writing or other media 2. Deliver the conclusion based on the analysis of oral, written or other media.

4. Data Analysis Techniques

Data were analyzed by descriptive qualitative. Data were analyzed by using the steps in the scientific approach with Permendikbud No. 81A in 2013 that includes observing, asking, try, associate (reasoning), and communicate. The analysis is based on a Permendikbud No. 81A in 2013 are presented in Table 1 and the criteria for assessment and categorization are presented in Table 2.

TABLE 2. Criteria Range Score and Category of Scientific Learning

Criteria Curve Normal	Range Score	Percentage	Category
$>Mi + 1. Sdi$	> 35	$84,4\% \leq X \leq 100\%$	High
$Mi - 1. Sdi$ s.d $Mi + 1. SDi$	25 s.d 35	$71,1\% \leq X < 84,4\%$	Medium
$< Mi - 1. Sdi$	< 25	$55,5\% \leq X < 71,1\%$	Low

RESULTS AND DISCUSSION

Description of Data

The results obtained in this study is the data of observation learning in the in the laboratory with a scientific approach to the physical chemistry experiments at the Islamic University of Indonesia. Data retrieval implemented during practicum title seven times (*meeting*). results obtained by the observers during the practicum takes place, and the observer is given the technical guidelines in the observation and how to fill in the observation sheet scientific approach. The experiment was conducted on seven titles physical chemistry experiments, namely 1) the thermochemical; 2) concentration of micelle critic; 3) adsorption isotherm; 4) viscosity of flow power; 5) kinetics in alkaline solution; 6) the solubility as a function of temperature and of 7) photocatalyst. Results from the study will be explained as follows:

a. Data from Observation Activities Learning with Scientific Approach in Physical Chemistry Experiments

Data from observation of learning activities with a scientific approach in the laboratory covers five activities: to observe, ask, try, associate (reasoning), and communicate. The results of the data analysis of the scientific approach to the observation sheet are presented in Table 3.

TABLE 3. Step Scientific Approach that Observed and the Results Obtained

Step of Learning Scientific Approach	Learning Activity	Mean of Score	Maximum Score	Percentage (%)	Category
Observing	1. Reading	53	72	73,98	Medium
	2. Viewing or Sensing (without or with tool)				
Questioning	1. Asking questions about the information that is not understood from what is observed	59	72	81,79	Medium
Experimenting	1. Conducting experiments	68	72	80,74	Medium
	2. Reading of sources other than books				
	3. Observing objects / events				
	4. Activities (learner activity)				
	5. Documentation the facts				
Associating	1. Finding links between the various information collected	55	72	76,94	Medium
	2. Processing of information collected for search of solutions from a variety of sources that have different opinion				
	3. Processing information collected for search of solutions from a variety of sources that contradict				
Communicating	1. Deliver the result of observations orally, in writing or other media	62	72	86,11	High
	2. Deliver the conclusion based on the analysis of oral, written or other media.				
	3. Able to be responsible toward information that has been submitted with able to maintain the idea conveyed				

Description levels of scientific learning process with scientific approach was explaining that the data of learning activities process was collected using observation sheet. Guidelines for observation was conducted over seven times that consists of five aspects, which maximum Score every aspect is 3 and the smallest score is 1. If converted into category will consist of three categories, that is score was classified of level scientific high, medium, and low. Descriptive of analysis was intended to find levels of scientific in the learning process with the scientific approach to the subjects physical chemistry experiments. Based on analysis of learning process about scientific approach the was obtained the results that are presented in Table 4. below.

TABLE 4. Results Descriptive analysis of the implementation of the approach scientific and category of scientific

No	Scientific Approach Aspect	Mean	Category
1	Observing	53	High
2	Questioning	59	High
3	Experimenting	68	High
4	Associating	55	High
5	Communicating	62	High

From the results of the descriptive analysis then learning achievement with scientific approach was made in the form of percentages that was presented in the form of a diagram in Fig.1 below.

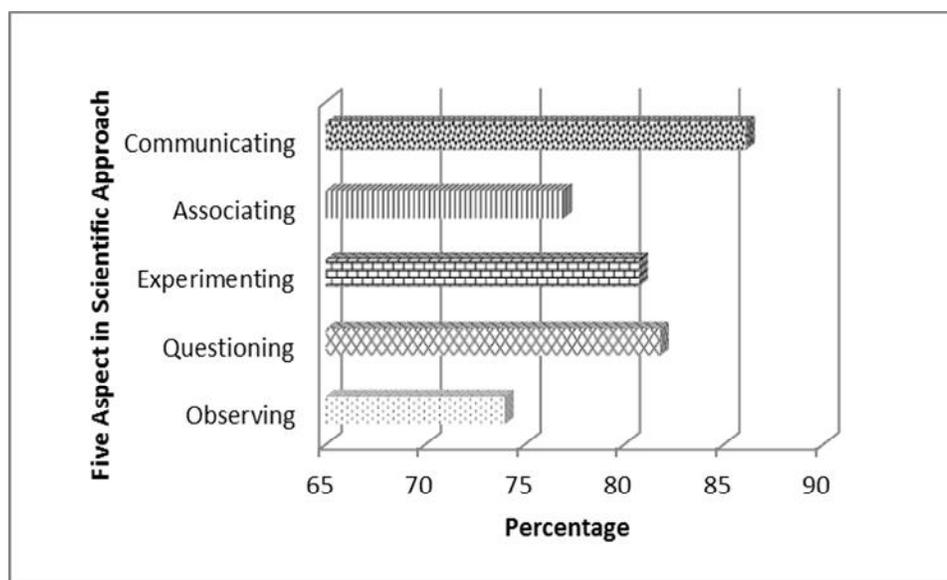


FIGURE 1. Histogram of percentage aspects of the scientific approach in Physical Chemistry Experiments

From the analysis results are also obtained percentage of data for each aspect and the seven title of experiments that has been implemented. These percentages are presented in Fig.2 below.

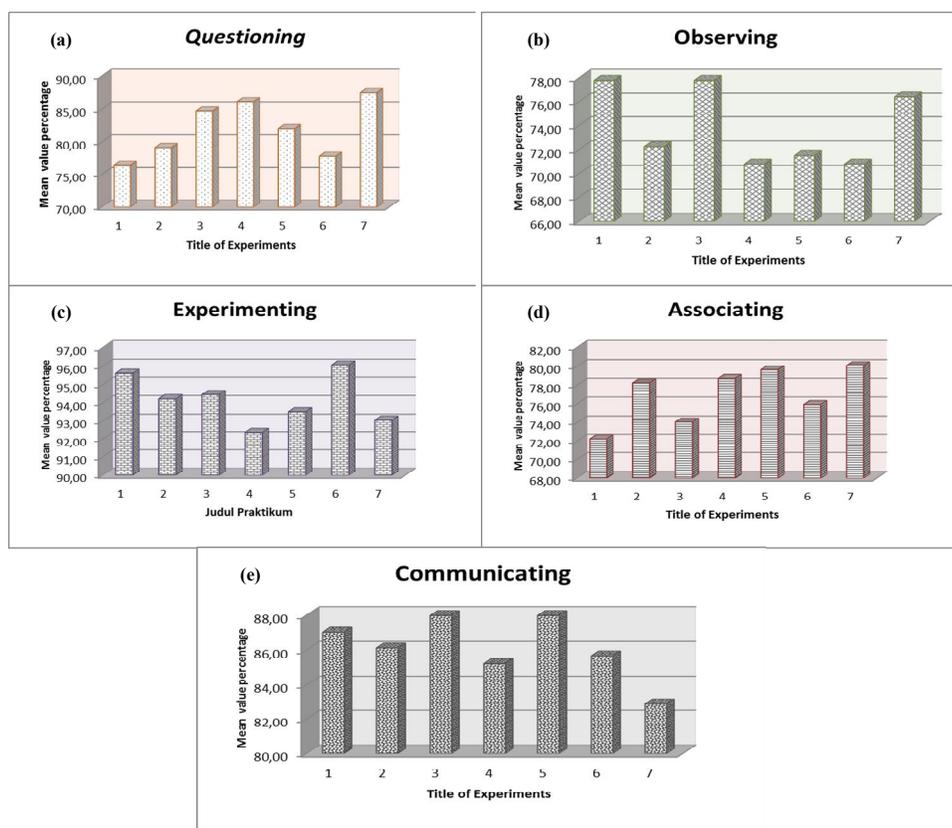


FIGURE 2. (a) The percentage achievement of questioning aspect, (b) the percentage achievement of observing aspects, (c) the percentage achievement of experimenting aspect, (d) the percentage achievement of Associating aspects, (e) the percentage achievement of communicating aspects

Discussion

Based on the results of the study, found that the five aspects of the scientific approach had an average score of the high category (Table 3). This suggests that the process of learning physical chemistry experiments run optimally in the use of scientific approach. Scientific approach has the major components that prioritizes the role of learners in the learning process: 1) observing, 2) questioning, 3) get information. 4) associate, 5) communicate. In addition the students are given the widest possible opportunity to construct their own knowledge [11]. The learners can doing good learning process in this opportunity. That opportunity were given can the learners was obtained if they were able to implement the learning process well. The scientific approach also affects the learning outcomes of students because it involves process skills such as: classify, measure, predict, explain, and concluded [12]. In another study also mentioned that learning with the scientific approach can improve learners activity [13]. Therefore, activity of scientific learning is able to provide a positive impact on learning outcomes of students because learning with scientific approach is learning activities that link the concepts that exist in theory to real life, which is able to motivate learners to learn more through active learning. In another side of levels of scientific , this study also analyzes the achievement of the results obtained of five the scientific approach. These five aspects have percentage the successful implementation different: the percentage of observing at 73.98%; questioning at 81.79%; experimenting at 80.74; associating at 76.94 and communicating at 86.11%. In the aspect of observing, questioning, experimenting, associating and communicating can be seen in FIG 2, and each of these aspects there are titles of experiments that have high percentage. However, a high percentage for each aspect as varied as the questioning aspects, seventh title have highest percentage. For aspect of observing, title of 1 and 3 have highest percentage. In

aspect of experimenting, title of 6 have highest percentage, in aspect of associating, title of 7 have highest percentage too, and the latter in the aspect of communicating, the title of 3 and 5 who had the highest percentage.

This difference is because each title of practicum conducted have levels of difficulty different when viewed from the tools and materials used. In addition, each title of practicum, should be implemented with fifth of aspect of the approach scientific completely, so that when the observations were made for each aspect, of course there is the use of tools or materials that can foster motivation and curiosity of students who cause them more leverage in implementing scientific approach in the practicum. Furthermore, when seen from the percentage of aspects on the scientific approach, communicating has the highest percentage. In pelaksanaan communicate, the student is required to deliver the results of experiments that have been done orally or tertulis, conclude and responsibility for the results of their experiments. When students successfully carry out an experiment and get the appropriate results, then it is able to increase their confidence level when the delivery of the results of the experiment. Experiments have been done and get results and be able to prove a theory being real able to give satisfaction to students in the form of confidence. With the confidence of this, the students are more enthusiastic when given the opportunity to communicate the results of experiments for another students. From some of the results obtained show that the scientific approach petrified facilitate students to understand the material theoretically and applicative. This is also reinforced by the one research that the learning activities are carried out in the laboratory more effective to increase motivation and activeness of students so activity in the laboratory, with the approach of the scientific can be used as an alternative to combine methods conceptual and theoretical with the practical that is also able to increase the student science process skills [14,15].

CONCLUSION

Based on the results of research and discussion it can be concluded that the application of scientific approach in physical chemistry experiments give results on their lessons. scientific learning in students of chemical education department for physical chemistry experiment have high criteria and the highest score obtained in the scientific approach to aspects of communicating with the percentage 86.11%, While results of the analysis of each aspect shows that the implementation of learning with the scientific approach can improve motivation, curiosity and confidence of students.

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